SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, APRIL 1938

By IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parenthesis). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

During April 1938 direct solar radiation intensities averaged below normal at Washington and above normal at Madison, Lincoln, and Blue Hill.

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

During April 1938 all stations showed an excess in the total solar and sky radiation with the exception of Washington and the two California stations, Fresno and Riverside.

Polarization measurements made at Madison on 6 days give a mean of 54.4 percent with a maximum of 61.5 percent on the 9th. Both these values are below the corresponding normals for the month.

TABLE 1.—*Solar radiation intensities during April 1938*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Apr. 11	3.99	0.73	0.84	0.98	1.12	1.41					2.26
Apr. 13	7.29				0.81						5.56
Apr. 14	8.48		.43	.57	.84						7.29
Apr. 19	8.81		.84	.98	1.22	1.49					6.02
Apr. 20	9.47			.89	1.08						8.48
Apr. 23	3.30			1.09	1.24	1.50					2.74
Apr. 25	5.13			.60	.86						5.79
Apr. 26	9.14						0.81				8.81
Apr. 27	10.59						.96				12.24
Apr. 28	11.38			.53	.73						12.68
Means		(.73)	.70	.81	.99	1.47	(.90)				
Departures		+.03	−.08	−.08	−.08	−.04	−.18				

MADISON, WIS.

Apr. 4	2.06					1.58					1.52
Apr. 9	2.74		1.12	1.27	1.38	1.60					2.36
Apr. 12	5.36			.79	.99						6.02
Apr. 18	7.87		.95	1.10	1.30	1.55					1.37
Apr. 20	3.99					1.56					4.75
Apr. 22	3.63			1.21	1.38	1.56					3.45
Apr. 27	8.47			.88	1.04						12.24
Apr. 30	4.95			1.22	1.39	1.60					2.87
Means			(1.04)	1.11	1.25	1.58					
Departures			+.11	+.07	+.05	+.13					

LINCOLN, NEBR.

Apr. 1	1.96							1.19			1.88
Apr. 2	2.06	1.00	1.10	1.25	1.44	1.61	1.38	1.18	1.05	0.93	1.68
Apr. 4	3.15					1.50					2.87
Apr. 8	2.74						1.36	1.18	1.02		2.74
Apr. 9	3.63	.95	1.07	1.20	1.36	1.59	1.33	1.13	0.98	.88	3.05
Apr. 10	4.17	.89	1.01	1.16	1.28	1.45					4.57
Apr. 11	7.87		.40	.51	.75	1.54	1.31	1.10	.98	.86	5.56
Apr. 12	5.16	.88	.98								4.57
Apr. 17	7.04	.71	.79	.98	1.20	1.48					7.57
Apr. 18	7.57			1.08	1.26						9.14
Apr. 20	4.95	.31	.43	.69	1.02	1.49					3.81
Apr. 21	6.27					1.56	1.37	1.20	1.06	.97	3.99
Apr. 22	3.81	.83	.98	1.14	1.31	1.53					3.81
Apr. 25	10.59						1.01	.87	.70	.59	14.10
Apr. 28	5.56						1.22	1.05	.90	.76	7.04
Apr. 29	7.57				.98	1.46					10.97
Apr. 30	10.21						1.16	.95	.79	.68	7.87
Means		.80	.84	1.00	1.18	1.52	1.27	1.09	.94	.81	
Departures		+.08	+.01	+.03	−.01	+.06	+.10	+.14	+.12	+.12	

BLUE HILL, MASS.

Apr. 1	8.2			1.12	1.29	1.38	1.19				4.8
Apr. 3	2.4				1.25	1.54	1.45	1.06			2.0
Apr. 7	2.6					1.43	1.25	1.15	1.02		2.2
Apr. 11	1.6			1.14	1.25	1.42	1.17				2.5
Apr. 16	4.4		0.96	1.12	1.28	1.44	1.26	1.08	.94		5.8
Apr. 17	4.2				1.30	1.45					3.2
Apr. 19	10.4			1.00	1.21	1.32					8.8
Apr. 20	6.8				1.17	1.29	.95				6.3
Apr. 21	7.4					1.38					6.8
Apr. 24	4.4				1.21	1.39	1.17				7.1
Apr. 26	6.3				1.17	1.25	1.08				7.1
Apr. 27	6.8				1.07	1.20	1.08				7.9
Apr. 28	9.9					1.27	1.06				6.5
Means			(.56)	1.10	1.22	1.37	1.17	1.10	(.98)		
Departures			+.01	−.00	+.03	−.02	+.04	+.07	+.05		

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	Gram-calories per square centimeter																
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Apr. 2	189	405	392	222	262	542	385	437	566	469	351	525	432	613	389	178	420
Apr. 9	436	430	527	462	391	524	333	381	534	420	414	451	437	633	399	356	471
Apr. 16	263	428	521	446	402	615	409	532	502	531	390	512	437	704	426	282	441
Apr. 23	512	349	476	391	504	499	452	507	495	511	451	377	490	674	580	502	591
	Departures of daily totals from normals																
Apr. 2	−188	+36	−16	−62	−57	+27	+52	+6	+48	+4	−19	+28	+60	+44	+78	−72	------
Apr. 9	+27	+26	+82	+114	+69	−50	−43	−6	+45	−50	+18	−42	+75	+33	+101	+84	------
Apr. 16	−177	+29	+67	+104	+34	+15	+20	+57	+14	+53	−25	−12	+47	+55	+11	0	------
Apr. 23	+42	−80	+37	+36	+86	−73	+41	+3	−33	+33	+59	−111	+14	+48	+67	+48	------
	Accumulated departures since Jan. 1																
	−5,674	−3,353	−1,092	+1,288	+490	−2,674	+2,352	−4,398	−133	−721	+2,695	−1,589	+56	+3,750	+5,026	+3,647	------

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Mt. Wilson group No.	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	*h m*		°	°	°				
Apr. 1	9 25	5831	−68.0	273.2	−22.0	388	------	7	Mount Wilson.
		5830	−65.0	276.2	−27.0	194	------	1	
		5829	−58.0	283.2	+20.0	48	------	4	
		5832	−57.0	284.2	+16.0	24	------	1	
		5834	−21.0	320.2	+8.5	16	------	2	
		5833	−16.0	325.2	−18.0	12	------	1	
		5826	−9.5	331.7	−21.0	291	------	19	
		5828	+39.5	20.7	−20.0	48	------	5	
		5818	+68.0	49.2	−17.0	630	------	10	
		5818	+85.0	56.2	−13.0	339	1,990	------	
Apr. 2	9 23	5837	−78.0	250.0	−9.0	242	------	1	Do.
		5831	−55.0	273.0	−22.0	388	------	8	
		5830	−52.0	276.0	−27.5	194	------	2	
		5832	−43.0	285.0	+18.0	36	------	3	
		5829	−40.5	287.5	+21.0	24	------	5	
		5836	−40.0	288.0	+9.0	16	------	2	
		5826	+5.0	333.0	−20.0	291	------	11	
		5835	+13.0	341.0	−27.0	6	------	1	
		5818	+82.0	50.0	−17.0	436	1,633	2	
Apr. 3	12 26	5838	−71.0	242.1	+13.0	24	------	1	U. S. Naval.
		5837	−62.5	250.6	−9.0	218	------	2	
		5831	−40.0	273.1	−21.5	291	------	16	
		5830	−37.0	276.1	−27.0	121	------	2	
		5832	−29.0	284.1	+18.5	12	------	3	
		5829	−24.5	288.6	+20.0	24	------	2	
		5836	−24.0	289.1	+9.5	24	------	2	
		5826	+19.5	332.6	−20.0	242	956	9	
Apr. 4	11 3	5838	−59.5	241.2	+12.5	36	------	3	Do.
		5837	−49.5	251.2	−9.0	194	------	2	
		5831	−27.0	273.7	−22.0	267	------	13	
		5830	−25.0	275.7	−27.0	145	------	2	
		5832	−13.0	287.7	+18.0	48	------	2	
		5836	−11.0	289.7	+9.5	12	------	2	
		5829	−11.0	289.7	+20.0	24	------	2	
		(1)	+9.0	309.7	−11.5	12	------	1	
		5833	+25.0	325.7	−17.0	24	------	1	
		5826	+31.0	331.7	−20.0	194	956	3	
Apr. 5	11 8	5840	−81.0	206.4	−6.0	194	------	2	Do.
		5839	−52.5	234.9	−7.0	24	------	6	
		5837	−37.0	250.4	−9.0	194	------	1	
		5831	−13.0	274.4	−22.0	242	------	28	
		5830	−12.0	275.4	−27.0	97	------	2	
		5832	−2.5	284.9	+18.0	48	------	9	
		5826	+44.0	331.4	−20.0	242	------	9	
		(1)	+47.5	334.9	+17.0	12	1,053	1	
Apr. 6	14 15	5840	−69.0	203.5	−7.0	339	------	4	Mount Wilson.
		5839	−38.0	234.5	−7.0	97	------	2	
		5837	−22.0	250.5	−9.0	194	------	1	
		5831	+1.0	273.5	−23.0	194	------	3	
		5830	+2.0	274.5	−28.0	73	------	1	
		5836	+16.0	288.5	+10.0	145	------	4	
		5826	+60.0	332.5	−20.0	291	1,333	5	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Mt. Wilson group No.	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	*h m*		°	°	°				
Apr. 8	12 14	5842	−71.0	176.2	+28.0	970	------	10	Mount Wilson.
		5840	−44.0	203.2	−7.5	582	------	35	
		5839	−13.0	234.2	−7.0	48	------	2	
		5837	+4.5	251.7	−10.0	194	------	2	
		5831	+27.0	274.2	−23.0	24	------	2	
		5830	+29.0	276.2	−28.0	61	------	3	
		5836	+43.0	290.2	+9.5	36	------	3	
		5826	+85.0	332.2	−23.0	291	2,206	3	
Apr. 9	15 12	5844	−86.0	146.4	−12.0	436	------	1	U. S. Naval.
		5843	−83.0	149.4	−24.5	582	------	2	
		5842	−56.0	176.4	+28.0	1,454	------	16	
		5840	−29.0	203.4	−7.0	388	------	20	
		5839	+2.0	234.4	−6.5	48	------	5	
		5837	+19.5	251.9	−9.0	194	------	3	
		5830	+41.0	273.4	−28.0	121	3,223	1	
Apr. 10	11 41	5844	−74.0	147.1	−11.0	339	------	3	Do.
		5843	−71.0	150.1	−22.0	679	------	2	
		5842	−45.0	176.1	+27.5	1,261	------	14	
		5840	−16.0	205.1	−7.0	388	------	18	
		5837	+30.0	251.1	−9.5	145	------	1	
		5830	+52.0	273.1	−28.0	73	------	1	
		5845	+56.5	277.6	−32.0	36	2,921	2	
Apr. 11	11 3	5843	−69.0	139.3	−21.0	48	------	2	Do.
		5843	−59.5	148.8	−23.0	630	------	3	
		5844	−60.0	148.3	−11.0	436	------	1	
		5842	−33.0	175.3	+27.0	1,164	------	15	
		5840	−2.0	206.3	−6.0	339	------	11	
		5837	+44.0	252.3	−10.0	145	------	2	
		5830	+66.0	274.3	−27.5	73	2,835	1	
Apr. 12	11 18	5844	−47.0	147.9	−11.0	388	------	2	Do.
		5843	−46.5	148.9	−22.0	679	------	3	
		5842	−19.0	175.9	+27.0	1,164	------	12	
		5846	+7.0	201.9	+7.5	48	------	2	
		5840	+12.0	206.9	−6.0	339	------	15	
		5837	+58.0	252.9	−10.0	145	------	1	
		5830	+79.0	273.9	−28.0	24	2,787	1	
Apr. 13	11 9	5843	−33.0	148.8	−23.0	630	------	8	Do.
		5844	−33.0	148.8	−10.5	388	------	2	
		5842	−6.0	175.8	+27.0	1,115	------	27	
		5846	+20.0	201.8	+8.0	97	------	10	
		5840	+28.0	209.8	−5.0	242	------	14	
		5837	+70.0	251.8	−10.0	97	2,569	2	
Apr. 14	11 8	5848	−88.0	80.6	−11.0	388	------	2	Do.
		5847	−33.0	135.6	−7.0	12	------	2	
		5843	−20.5	148.1	−23.0	630	------	35	
		5844	−20.0	148.6	−10.5	388	------	18	
		5842	+8.0	176.6	+27.0	1,018	------	52	
		5846	+33.0	201.6	+8.0	73	------	12	
		5840	+44.0	212.6	−5.0	218	------	9	
		5837	+85.0	253.6	−10.0	97	2,824	2	
Apr. 15	11 3	5848	−76.0	79.5	−10.5	582	------	9	Do.
		5852	−72.0	83.5	+26.0	48	------	3	
		5851	−38.0	117.5	+16.0	24	------	4	
		5843	−9.0	146.5	−23.5	582	------	30	
		5844	−7.5	148.0	−10.5	388	------	25	
		5842	+18.0	173.5	+27.0	824	------	48	